

ON THE RELATIONSHIP BETWEEN MESOSPHERIC
CIRCULATION AND THE FREQUENCY OF NOCTILUCENT
CLOUDS

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Translation of "Über die Beziehung zwischen meso-
sphärischer Zirkulation und Häufigkeit der
Leuchtenden Nachtwolken", Gerlands Bei-
trage Zur Geophysik, Vol. 77, 1968, No. 4.
pp. 303-308.

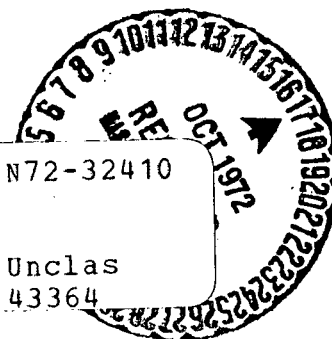
(NASA-TT-F-14415) ON THE RELATIONSHIP
BETWEEN MESOSPHERIC CIRCULATION AND THE
FREQUENCY OF NOCTILUCENT CLOUDS W.
Schroeder (NASA) Jul. 1972 8 p CSCL 04A

N72-32410

G3/13

Unclas

43364



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From: Gerlands Beitrage Zur Geophysik, v. 77, 1968, p. 303-308

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Received from the Author

Special Reprint from "Gerlands Beitrage zur Geophysik" Vol. 77, No. 4, (1968)

303 - 308

Akademische Verlagsgesellschaft Geest & Portig K.-G., 701 Leipzig

On the Relationship Between Mesospheric Circulation
and the Frequency of Noctilucent Clouds

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II

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SUMMARY

It is shown by the example of selected observations that a relationship exists between mesospheric circulation (Faust's model) and the frequency of noctilucent clouds. The prerequisite for the formation of noctilucent clouds are low temperatures and other components such as, sufficient H_2O conditions. During the winter circulation (descending motion according to Faust's model) no noctilucent clouds can be observed.

1. Observations

A necessary prerequisite for the treatment of noctilucent clouds (abbreviated NLC) are comprehensive catalogs. Unfortunately, observations of NLC have, up to now, been cataloged only sparsely so that presently very few compilations are available.

The work of Soviet researchers would be especially appreciated since they compile their observations in catalogs (see [1, 2, 21]). It is also convenient that the results of Soviet research are relatively easily obtained by the observer. It was therefore possible to use several series of Soviet observations for this study (see [4 - 6], [11], [17 - 22]). In addition to this, the English observations (see [12]) as well as the observations from Western Europe (see [13, 14]) and finally, the data by Roennebecker (see [15]) were used.

The degree of reliability of the observations is of decisive importance. For this it must be considered that the data are limited by external factors (meteorological conditions, distribution and personnel of the observation stations as well as individual psychophysical characteristics of the observer). Although in England, Roennebeck and in the region of the U.S.S.R. routine observatories are installed, they are not an absolute guarantee for continuous

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monitoring; it is therefore, impossible to make reliable statements as to the actual time at which a visual observation of the NLC was made for the first time in the year. Although it is possible to find out from the observation series the days on which an NLC was sighted for the first time, it cannot be seen from the reports on which (clear) days before that no NLC were seen.



Fig. 1: Photograph of a noctilucent cloud.

I gratefully received this picture from J. Paton, who also gave his kind permission for its publication.

Naturally on the other hand, it is simple to determine the accuracy of an observation if data and time are known. Since the position of the sun for this particular time can be easily determined, it can be decided whether the sighted object was actually an NLC.

Last, but not least, it is desirable to note the homogeneity of the observation network. In southern Europe no such network exists; only in the region of the U.S.S.R. does a comprehensive network of stations exist so that some degree of continuity is guaranteed (see Vasilyev [18]). On the other hand, simultaneous observations are possible during summer time for an area comprising approximately 10° of latitude and about 110° of longitude; by this means compilations can complement each other. Continuous monitoring can therefore be assumed to exist at least for the region of Eurasia (φ $50 - 60^{\circ}$ N).

2. Seasonal Frequency of NLC

When comparing the data obtained from England and the observations of German - Soviet origin, a significant difference can be seen. Approximately beginning with August, no NLC can be made in England. For Roennebeck, on the other hand, observations are still available from August/September and for the U.S.S.R. even from October/November.

The visibility for the NLC for the northern hemisphere is generally during the months April - August, where a maximum occurs during the month of July. Deviations from this could be caused by the geographical position of the observer.

As far as the winter months are concerned, there is no occurrence for NLC for Roennebeck or England. Occasionally reported sightings during the winter (Germany, 1885 - 1956) are not to be considered as actual sightings of NLC, as it was shown that the observations by Hamilton [10] was not an actual NLC. As far as the data are concerned, a generalized treatment will have to come from an expert in this country before observations made during the winter months can be evaluated.

It follows from these remarks that the NLC are strictly a summer phenomenon. It has to be assumed therefore, that it is only during the summer that specific conditions prevail which result in the formation of NLC.

Table 1

Year	UdSSR ¹⁾	Rönnbeck [15]	England [12]-[14]
1959	13. 5.-31. 8. 28. 6.-15. 7.	18. 6.-14. 7.	28. 5.-25. 7.
1960	4. 6.-18. 6. 27. 6.- 7. 7. 29. 6.-19. 9.	15. 6.-21. 7.	28. 5.- 3. 8.
1961	20. 6.- 9. 8. 24. 3.-13. 7.	15. 6.-13. 8.	12. 6.- 1. 8.
1962	8. 6.-30. 7. 19. 6.-20. 7. 1. 7.-15. 8.	7. 6.- 5. 8.	8. 6.-16. 7.
1963	14. 6.-28. 7. 1. 7.- 4. 7. 30. 6.-21. 8.	23. 6.-30. 7.	28. 6.-26. 7.
1964	17. 3.-24. 11. 7. 6.-25. 7. 8. 6.-29. 6. 13. 6.-15. 7. 3. 7.-30. 7.	9. 6.-16. 8.	9. 6.- 7. 8.

¹⁾ U.S.S.R. observations s. [2]-[6], [11], [17], [18]-[22].

We would like to discuss at this point the frequency of the NLC which varied from year to year. A number of different observations are given in table 1.

The yearly displacement can be seen from table 1. Since the stations are located in a nearly uniform region ($\varphi = 50 - 60^\circ$ N), the geographical position does not seem to be relevant for the displacement in sightings. If we now tabulate the earliest and latest observations, we arrive at the following:

Table 2

Year	Visibility	Mesosphere
1961	24. 3. - 13. 8.	Early
1962 ¹⁾	7. 6. - 15. 8.	Late
1963	14. 6. - 21. 8.	Late
1964	17. 3. - 16. 8.	Early

¹⁾ The German observations of 4/28/62 were left out because it was a single observation. Subsequent NEC not until June. The Soviet data for 8 - 9/64 are also omitted.

The significant result of the above tabulation is an apparently delayed or premature occurrence of the NLC for the years for which the change in the direction of the wind in the mesosphere occurred later or earlier. According to the data in table 2, the NLC could be observed continuously that is, the periods for NLC sightings had started.

As is shown in table 2, there are no marked differences during fall. As an example, the NLC disappeared constantly around 15 August for the years 1961 - 63; only Soviet data reports for 1964, sightings up to November, otherwise the same decay phase applies for this year as for the others. Up to now, measurements made by rockets did not show any such marked differences during fall as they apply to springtime. This seems to point to a relationship between the circulation in the mesosphere and the duration of the occurrences of NLC.

3. Discussion

It is significant that the NLC disappear during fall on a nearly constant date. As was already shown elsewhere (see [16]), noticeable deviations occur in countries during spring. It follows from these results that there is a relationship between the mesospheric circulation (see Faust [7 - 8]) and the frequency of NLC. The NLC occur, not until after a change of wind direction during spring took place. At the time this change occurs during the fall season, the periods of visibility of NLC is terminated. The deviations which occur are treated in [16].

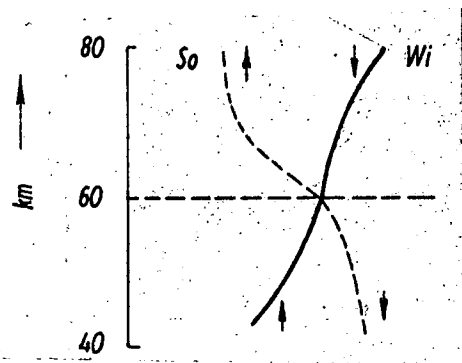


Fig. 2: Schematic of temperature distribution in higher latitudes (60° N).

The arrows signify the direction of vertical motion (according to Faust, [7], p. 25).

For the development of the NLC, it is not only necessary to consider the change of wind direction and the resulting cooling of the mesosphere, but also other conditions. For example, a sufficient content of H_2O is necessary so that the NLC can be formed within a foreseeable time. Only if these different components coincide, and NLC can be formed.

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